ENGINEERING NEWS.

Tribune Building, New York City.
GEO. H. FROST, PROPRIETOR.

SATURDAY, JANUARY 15, 1881.

THE HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.

From the first volume of this journal water-works construction has been a leading specialty of its pages; it has published more on that subject than all the other class papers of the country combined, and it is now very justly recognized as the best medium for reaching the attention of every person interested in public water supply. In 1877, '78 and '79, we published very full histories and descriptions of several leading water-works, especially those of Boston, Quebec, and Cleveland; in 1878 and '79 we published in book form the great work of Wm. Humber on water supply, which previously had been obtainable by but a very few, by reason of its great cost, which enterprise of ours has been most warmly appreciated by the profession. We have made attempts to compile a complete statistical history of American water-works but at the very outset we became appalled at the immensity of the undertaking, and so have succeeded only in collecting numerous reports and written communications on the subject, which we shall hereafter utilize. We now have started in upon the publication of a treatise, in weekly installments, that will undoubtedly prove to be the most valuable compendium of water-works information that any language can exhibit. An outline of the work was sketched in our last issue (page 11 *ante*), but our readers cannot therefrom wholly realize the vast amount of desirable memeranda on the subject with which our columns will be fairly crammed during the present volume. Of the peculiar fitness of Mr. Croes for the work he has undertaken we need not say anything here. He is recognized as one of the most skillful, painstaking and thorough sanitary engineers in the country, while at the same time he is a careful and patient investigator, and an accomplished writer on engineering subjects. We consider that, in securing the services of Mr. Croes for this special department of ENGINEERING NEWS, we have given to our patrons the very best assurances of the completeness with which it will be administered.

We are now fairly pledged to this important work; there are over six hundred water-works to be written about, and it is our intention to make a "complete job" of it and not overlook a single works. We intend to hammer away persistently at the door of every water-works Superintendent's office until we get the needed information and see that it is revised and corrected to latest date; this never has been fully accomplished heretofore, but as this final effort will forever after stop the current of circulars asking for information, constantly pouring in on water-works people, so we expect to receive the grateful assistance of those much questioned individuals. We now solicit reports and correspondence, so that we can be arranging our matter successfully in advance for use. The entire subject is at the disposal of Mr. Croes, but all correspondence must be directed to this office.

Our advertising patrons will not fail to appreciate the immense value of our undertaking. It effectually stamps ENGINEERING NEWS as *the* water-works journal of America, and we propose to make it of so much value as a medium for reaching the notice of parties in need of water-works machinery, that it *will not pay* to be unrepresented in its advertising columns. We are very grateful to the manufacturers of water-works machinery for their liberal support heretofore, and we propose to make special efforts to please them in the future, as we have in the past. Our rates are so low that the cost of a suitable advertisement is but a bagatelle in the yearly expenses of any establishment, and is money well invested.

Subscribers who wish the complete volume should send at once, as we shall not carry a supply of back numbers, and a month hence it will be impossible to furnish any such. We shall advertise this special feature of the present volume very completely in Europe, and feel certain that every copy of the present volume will be wanted by European engineers. A word to the wise ought to be sufficient.

PERSONAL.

On last Thursday, General U. S. Grant was elected a member of the World's Fair Commission, and was also made its permanent president.

W. C. Irwin has been appointed Engineer of Bridges on the Cleveland, Columbia, Cincinnati & Indianapolis Railroad, with headquarters at Cleveland.

We published last week a notice of the death of Wm. Lighthall, the oldest marine engineer in the country. We copied the paragraph as we found it in an exchange, but our attention has been called to the fact, which we find in Thurston's "Growth of the Steam Engine," that the "Clermont" was launched in 1807, at which time Mr. Lighthall was just three years old. We learn, however, from a correspondent, that Mr. Lighthall was a fireman on board the steamboat "Chief Justice Marshall" in 1827, he having previously been in the employ Mr. Starbuck, of Albany. Mr. Lighthall's death leaves Mr. Charles H. Haswell, of this city, the oldest marine engineer in service, not only in this section but probably in the United States.

ENGINEERING ABROAD.

(From our own correspondent.)

PARIS, Dec. 27.

The great questions here at present are the supply of water, and the disposal of the sewerage. The latter question has become so pressing that everybody says something must be done. The *odeurs de Paris* were so offensive during the whole summer that persons became sick from them, while all the zymotic diseases increased. The engineers of Paris have devoted several sittings to the consideration of the subject, and the whole question has been treated so exhaustively that a condensed translation of the papers read cannot fail to be interesting. It is now generally admitted that nothing can give us a satisfactory solution of the difficulty except the thorough drenching, as it were, of every house. The system which prevails at present in Paris and other cities is the water tight closet; there is also in use the moveable closet, which, though offering some advantages, is still too costly. But here very little improvement has been made. The old style pump is still in vogue, although the Keiser pump is being rapidly adopted. The difficulty of destroying the mephitic gases still remains, however, for no substance can be mixed thoroughly with the matter of the closets. The system of atmospheric pressure for emptying has been in successful operation in some of the western districts of the city. It has been found that in order to obtain a vacuum of 70 c. of mercury, 2½ times the volume of the receiver must be withdrawn by the pumps. The system adopted in Holland, of having iron pipes leading direct from the closet to an iron vessel under the sidewalk, and admitting of a thorough pumping out, has been found very satisfactory. To dispose of the sewage is, however, a problem of great difficulty. The peninsula of Gennevilliers has been used for some time as a general dumping ground, but the opposition of the property owners has been very great, and, it must be admitted, justified.

The sewers discharge every twenty-four hours some 262,646 cubic meters of matter. This mass of liquid mud is thrown into the Seine by the two collectors at Asnières and Saint Denis. The deposits formed in the river involve dredging, at a cost of 200,000 francs annually. But the bed of the Seine is gradually being filled up, and one-fourth of it is now a mass of mud—a regular focus of fermentation and infection. The experiment at Gennevilliers was begun in 1866, and now some 700 acres receive the sewage. But there is a limit to the utilization of sewage for agricultural purposes, and, as the amount of rain varies every season, it is evident that irrigation may sometimes be more of an injury than a benefit, and, in any case, what is practicable for small towns becomes utterly impossible for cities like Paris and London. Let us now see the various methods that have been resorted to for getting rid of the sewage. The Johnson process is said to give satisfaction in London. It consists in mixing the sewage with lime, and then collecting the product in filter presses; but a trial of lime did not prove a success in Paris. The Gautier & Gueroult process applies an hydraulic pump to the matter, which is previously treated by a precipitant, and then decanted. The Cavalier process is yet in an experimental condition, but the inventor used a re-agent which he keeps secret. The Hennebute and Vaureal system consists of two operations: First, the separation of the solid from the liquid matter, by adding two to three milliemes of sulphate of zinc, and then from five to twenty milliemes of lime. The matter is decanted after a few hours, and the solid parts passed through Farinaux filtering presses, secondly, distillation of the liquid part, which is added to the filtered matter, and sent to special apparatus for the manufacture of the sulphate of ammonia. The Coquerel process uses phosphate acid of alumina in mixture with the sewage, and then heats to 75° C; it is then passed through an ordinary Farinaux filtering press. The liquids require, however, an enormous quantity of lime to disengage the ammonia. Some experiments are making at Boudy with this method, but it is more suitable for insoluble matters. Collet's system is based on the use of a re-agent, which looks like black powder, and which is probably the sulphate of the peroxide of iron, in a dose of from 275 to 280 kilos. Gas is disengaged extensively, and after being allowed to remain four or five hours, the liquid is drawn off, and the solid matters put in large cylinders, and from 200 to 250 kilos of phosphate and sulphate of lime added. A shaft with pallets works up the mass, while a current of hot air traverses the cylinder. Complete dessication is obtained after seven or eight hours. The Firmann and other methods, are almost similar, and have given similar results.

That the system of fixed closets, without con

nection with the sewers, has some supporters, even among medical men, is well known, the position taken being that the transformation of local matter in the closets destroys all organisms, and that the urea is changed into carbonate of ammonia, with a little sulfo-hydrate. The connection of the closets with the sewers, and consequently with the air, is looked on with some apprehension. But there really seems to be no system which can offer the same advantages as the sewer, were it not that the Seine will be rendered unbearable.

The use of lime water, and the clarification of the sewage before being sent to the Seine, would offer another solution.

THE METALLIC VIADUCT OF GARABIT.

This viaduct offers some peculiarities of construction which are worthy the attention of engineers. It crosses the valley of Trueyre (Department of Cantal) at a height of 125 meters above the river. The breadth of the valley is about 550 meters. The builder of the bridge over the Douro, at Oporto, M. Eiffel, was applied to for the plan. The necessity of not exceeding the present limits of metallic piles induced a mixed system of brick work and iron. The total weight of the bridge was about 3,200 tons.

NEW WORK ON COMPRESSED AIR.

Compressed air was employed to an unusual extent by Messrs. Couvreux and Hersent in their works at Antwerp. A treatise by M. Anspach gives an historical account of the use of compressed air since the time of Triger, in 1841. A description is given of the principal bridges which have been laid by the system, viz., those of Noordzee, Szegedin, Kehl and the East River. M. Anspach believes that there is a future before this engineering agent.

CORRESPONDENCE.

SHARPEST ALLOWABLE RAILROAD CURVE.

PITTSBURGH, Pa., Jan. 11, 1881.

EDITOR ENGINEERING NEWS:

Several answers having been furnished to "S. E. R.'s" question in ENGINEERING NEWS, of date of Dec. 11, 1880, in regard to sharp railroad curves, allow me to present an example of what I consider perpaps the sharpest turnout curve in existence in the United States, and which occurs on the Pittsburgh & Castle Shannon Railroad, whose gauge is 40 inches. The curve of the turnout in question forms one leg of a "*wye*," and has a radius of 100.43 feet, or equal to a 59° 43′ curve, and turns off from the outside of a curve having a radius of 322.45 feet, or a 17° 50′ curve. This turnout has been in successful operation for some years, and no difficulty is experienced in the use of the same.

Respectfully, EMILE LOW, C. E.

CORRECTION OF HENCK'S FIELD-BOOK.

In looking in my Henck to see whether the error mentioned in a late number of the NEWS was corrected, I found that I had corrected that error and also one just above it, viz.: the sin. of 33° 37′ should be 9.743223, instead of 9.743233. The sin. of 12° 30′ is also wrong; it should be 9.335337. Also the cos. of 34° 55′ should be 9.913806. If any one knows of any more, let us hear from him.

CHAMPAIGN, Ill. L. O. B.

ERRORS IN CALCULATING FROG DISTANCES.

BROOKLYN, Jan. 11, 1881.

EDITOR ENGINEERING NEWS:

In your issue of Jan. 8 you have a communication from Mr. Emile Low, headed "Error in Calculating Frog Distances," in which he gives a "correction" to a rule in "Roadmaster's Assistant" for calculating the length of switch rail for a given radius R, which seems to me to be incorrect. For the assumption made it strikes me that the rule in "Roadmaster's Assistant" is correct for switches as now put in. By it the length of a switch rail, which makes a slight angle with the main track where it leaves it, but is tangent to the curve of turnout at other end, is determined for a given radius R. By Mr. Low's rule, if written

$$\sqrt{R^2-(R-\text{throw})^2},$$

you would get the length of a switch rail, which would form a slight angle with curve of turnout as well as with the main track; if taken as given in his letter the result would be imaginary.

I have worked out some rules for frog distance and radius of turnouts from either straight or curved main track, which are approximate, it is true, still the greatest possible error is only 2½ inches in the length of any frog distance; an error which is certainly of no importance in practice. They possess the great advantage of having no trigonometrical functions to bother the heads of persons using them. Such being the case, and as I have never come across them before, I think, perhaps, you may find them worth giving to your patrons. I find for either straight or curved main track, and for side track on either side of main track,

$$\text{Frog-distance} = 2\,(\text{gauge of track}-\text{throw of switch}) \times \frac{\text{No. Frog} \times \text{length of switch rail.}}{\text{Switch-rail} + \text{No. frog} \times \text{throw in ft.}}$$

For radius of turnout from straight main track $= r$,

$$r = 2\,(\text{gauge}-\text{throw}) \times \frac{\text{No. frog}^2 \times \text{length of switch rail}^2}{\text{Switch-rail}^3 - \text{No. frog}^3 \times \text{throw in ft}^2}$$

For radius of turnout from curved main track $= r'$ from same gauge, throw, switch-rail and frog, and for radius of curved main track $= R$ we would have, when we make degree of curvature $= \frac{5730}{R}$.

Deg. curv. r' = deg. curv. $r \pm$ deg. curv. R.

Deg. curvature R is to be taken + when the turnout crosses the inner rail of curved main track, and negative when it crosses the outer rail. The result of these equations can be given in two very simple rules, viz.:

I. For a given gauge of track, throw of switch, switch rail and frog, the frog distance is the same whether the turnout be from a straight or a curved main track, and also whether it crosses the inner or outer rail of curved main track; the radius of turnout only is affected.

II. For a given gauge, throw of switch, switch rail and frog, the degree of curvature of a turnout from a curved main track is equal to the degree of curvature of a turnout from a straight main track for same gauge, etc., + or — the degree of curvature of the curved main track according as the turnout crosses the inner or outer rail of the main track.

Respectfully yours,

E. A. RUDIGER.

NEW BOOKS.

THERMODYNAMICS. By ROBERT ROENTGEN. Translated, revised and enlarged by A. JAY DU BOIS, Ph.D. John Wiley & Sons, New York, 1880.

Professor Du Bois has again added to our engineering literature by his translation of Roentgen's admirable work on Thermodynamics. It would be doing, however, scant justice to the work to characterize it merely as a translation. Roentgen has undoubtedly furnished the groundwork—but the value of the volume before us is considerably enhanced, not only by the felicitious mode of presentation, peculiar to Professor Du Bois, but also by numerous notes and well selected additions.

The two lectures on Thermodynamics delivered before the chemical society of Paris by Professor Verdet form a most fitting introduction to the book, and give a clear exposition of its subject and scope. A careful perusal of these lectures and the appended notes will be of great aid to the student of the succeeding chapters.

The division of the parts of the book is extremely well chosen, and the treatment and arrangement of the successive chapters thoroughly logical.

The "Examination Questions" appended to the different chapters, the many valuable tables and profusely interspersed *graphical* demonstrations and solutions, together with the many practical examples, make the book as valuable as a work of reference as it unquestionably is as a text-book.

It is perhaps to be regretted that even Prof. Du Bois should feel the necessity of catering to the unreasonable prejudice against the use of the calculus—there is no field in which its superiority over the tedious algebraic processes can be better demonstrated than that of Applied Mechanics.

The publishers have evidently not been sparing in their efforts to make the book a success; both paper and typographical work leave nothing to be desired.

NOTES ON THE ACTION OF FURNACES, BOILERS AND STEAM ENGINES.

[*Abstracted from various sources.*]

I.

SATURATED AND SUPERHEATED STEAM.

When water is confined in a boiler or other close vessel, part of the space being unoccupied by the liquid, the circumstances of the application of heat are as follows: The water being heated to 212° F., the space above the water becomes filled with steam or vapor, having an elastic force of one atmosphere, or 14.7 pounds per square inch. If more heat is applied to the mixture of water and steam, the boiler remaining closed, an additional quantity of steam will be formed, the quantity of water will be correspondingly diminished, an increase of elastic force or pressure will be observed, and these new relations will remain fixed for any given higher temperature, so long as that temperature is constant. If the boiler is now cooled, reverse phenomena will occur; a certain portion of the steam will be condensed in a liquid form, and the elastic force will be diminished. If the steam is allowed to escape, or the steam space is enlarged in any way, the temperature being kept constant, an additional quantity of vapor will be formed and the elastic force will remain constant. If the steam space is contracted, the temperature remaining constant, condensation of vapor will occur and the pressure will remain constant.

It is thus seen that, where steam is found in the presence of water, there is a corresponding elastic force or pressure, which cannot be changed without causing either evaporation of more water or condensation of some of the steam. As the steam space thus contains the greatest possible quantity of *steam* to the cubic foot for any given temperature, the steam in this condition is said to be *saturated*. If the quantity of water is small relatively to the size of the boiler or containing vessel, and heat is continuously applied, the last particle of liquid will finally be converted into vapor. At this instant the vessel will contain *saturated* steam only, unmixed with liquid water. The steam will be known as *dry saturated steam*, as distinguished from steam which may carry with it more or less of water in vapor or spray. If, now, additional heat is applied, or, if the space is enlarged while the temperature remains constant, the steam will assume what is termed the *superheated* condition. If the volume of the vessel is increased, the temperature remaining constant, the pressure will diminish, but it will no longer be solely proportional to the temperature, as in the case of saturation; it will depend also upon the volume, and the vapor begins to partake of the properties of the permanent gases. Superheated steam always exerts a pressure in-

ferior to that which belongs to saturated steam of the same temperature; and, if a quantity of saturated steam and another quantity of superheated steam exist under the *same pressure*, the temperature of the superheated steam will be the greater.

If we accept the molecular theory, which teaches that the pressure of a gas against the containing vessel is due to the impacts of the molecules, which have a greater velocity according to the higher sensible temperature, we see that saturated steam, having more particles of water to the cubic foot, will show a higher pressure than superheated steam of the same temperature; and that superheated steam, to give an equal pressure, must have a greater velocity imparted to its molecules, that is, must have its temperature raised. We can thus easily remember the relative relations of pressure and temperature for these two kinds of steam.

The following is the formula, as deduced from Regnault's experiments, for calculating the pressure p in pounds on the square inch above a vacuum from the absolute temperature T, which is the observed temperature t of Fahrenheit's thermometer plus 461.°2, the number of degrees from what is called "absolute zero" 0° F.:

$$\log p = A - \frac{B}{T} - \frac{C}{T^2}$$

whence

$$t = 1 + \left\{ \sqrt{\left(\frac{A - \log. p}{C} + \frac{B^2}{4C^2} \right)} - \frac{B}{2C} \right\}.$$

Substituting the value of the constants, we get

$$\log p = 6.1002 - \frac{2731.62}{t \times 461.2} - \frac{396944}{(t \times 461.2)^2}$$

For convenience of computation by logarithms, we have log B. = 3.43642, log. C = 5.59873.

Most books treating of this subject give tables of pressures and temperatures of saturated steam. A condensed table follows below, containing the temperatures to the nearest degree which correspond to pressures shown by the steam gauge from 0 to 120 lbs. per sq. inch.

Temp. F.°	Absolute pressure in lbs. per sq. in.	Pressure above atmosphere.
32	0.00	
60	0.26	
100	0.93	
212	14.70	0
239	24.55	10
259	34.90	20
274	44.78	30
287	55.08	40
298	65.22	50
307	74.56	60
316	85.02	70
324	95.18	80
331	104.97	90
338	115.34	100
344	124.95	110
350	135.08	120

It is worthy of note that while the thermometer indicates a change of 27° as the pressure rises from 0 to 10 lbs., a rise of 6° Fahrenheit will carry the pressure from 110 lbs. to 120 lbs.

II.

HEAT REQUIRED FOR THE PRODUCTION OF STEAM.

In the process of evaporation at any pressure, water must first be heated from a given initial temperature to the temperature of evaporation, or the "boiling point due to the pressure." To measure the heat required, a *unit of heat* is employed, which is the quantity of heat required to raise the temperature of one pound of water through one degree Fahrenheit, when at or near its temperature of greatest density, 39°.1F. Heat and mechanical energy are mutually convertible, and heat requires for its production (as, for instance, in heating by friction), or produces by its disappearance (as in operating an engine), mechanical energy or work in the proportion of 772 foot pounds for each unit of heat. The specific heat of any solid or liquid substance is the amount in units or part of a unit of heat required to raise the temperature of the one pound of the given substance through 1° F. The quantity of heat required to raise water to its boiling point depends on the specific heat of water, which varies slightly with the temperature, but is often taken as unity.

Next comes the quantity of heat necessary for *evaporation* of the liquid. This quantity of heat is usually called the latent heat of vaporization (latent signifying concealed), because, if the pressure remains constant during the vaporization, the temperature also remains constant, and the heat thus added to the hot water to evaporate it has disappeared, to be restored upon condensation.

This heat of evaporation is composed of two parts, one of which is the heat required to overcome the energy of molecular attractions, and the other part the external work exerted by the vapor in expanding against the constant pressure from the volume of the water to the volume of water and steam produced under the given pressure. If the increase of volume = u in cubic feet, and the pressure = p in lbs. on sq. inch,

Work of expansion in ft. lbs. = 144 p u.

External work, in units of heat = $\frac{144}{772}$ p u.

Hence, if m = heat required to overcome molecular attractions,

Heat of vaporization = $m + \frac{144}{772} p u$.

From experiments of Regnault it was determined that the *total* heat in one pound of steam of a temperature t° F is

$H = 1091.7 + .305\,(t - 32°)$,

which formula for practical purposes may be written

$H = 1092 + 0.3\,(t - 32°)$.

If the sensible heat, that required to raise the water to the boiling point, is substracted, one unit for each degree when the specific heat of water is taken as unity, the latent heat or

Heat of vaporization = $1091.7 - .695\,(t - 32°)$.

Or practically = $1092 - 0.7\,(t - 32°)$.

By the substraction and addition of 126 we get also

Heat of vaporization = $966 - 0.7\,(t - 212°)$.

The latent heat vaporization of one pound of water, according to this last formula, at atmospheric pressure, is found by substituting 212° for t, and amounts to 966 units of heat.

If the heat required to raise one pound of water from 32° to any temperature t_1, such as the temperature of the feed-water in the boiler, is subtracted from this quantity, the total heat required to raise one pound of water from feed-water temperature to the temperature of evaporation and evaporate it at that temperature is

$$H = 1091.7 + 0.305\,(t - 32°) - (t_1 - 32°).$$

Example: If the steam gauge on a boiler indicates 60 pounds pressure, and the feed-water is introduced at 50° F., we find, from the table or formula in Art. I., that the boiling point corresponding to this pressure is 307° F.; therefore the total heat required to convert one pound of feed-water at 50° F. into steam at 60 lbs. pressure above the atmosphere is

$H = 1092 + .3\,(307° - 32°) - (50° - 32°) = 1156.5$ units of heat.

If from a pound of coal we can obtain in the boiler 8,000 units of heat, then one pound of coal ought to convert 7 lbs. of water at 50° F. into steam of 60 lbs. pressure above the atmosphere.

The latent heat of evaporation of steam in units of heat per cubic foot of space is, in the notation of the previous article,

$$L = \frac{144\,p}{772}\left(\frac{B}{T} + \frac{2C}{T^2}\right) 2.3026$$

$$= 0.421\,p\left(\frac{2,731.62}{t + 461.2} + \frac{793,888}{(t + 461.2)^2}\right).$$

The following proportion may be written: Increased volume from one pound of water to one pound of steam: One cubic foot = heat of vaporization for one pound: heat of vaporization in one cubic foot. Therefore, the increase of volume

$$v - v' = \frac{\text{Latent heat of vaporization for one pound}}{\text{latent heat of vaporization for one cubic foot.}}$$

$$= \frac{1,091.7 - 0.695\,(t - 32°)}{0.421\,p\left(\frac{2,731.62}{t + 461.2} + \frac{793,888}{(t + 461.2)^2}\right)}.$$

In the example above cited, the increase of volume of one pound of water, when converted to steam of 60 lbs. pressure, will be practically

$$\frac{1,092 - 0.7\,(307 - 32)}{0.421 \times 74.7\,(3.556 + 4.901)} = 5.84 \text{ cubic ft.}$$

As one pound of water will occupy but about $\frac{1}{62.5}$ of a cubic foot, one pound of saturated steam at 60 lbs. above the atmosphere will occupy 5.86 cubic feet.

Volumes of one pound of saturated steam at pressure from 0 to 120 pounds on sq. inch above the atmosphere.

Temp. F.	Pressure above atmosphere.	Vol. of 1 lb. in cu. ft.
212°	0	26.4
239	10	16.1
259	20	11.6
274	30	9.2
287	40	7.6
298	50	6.5
307	60	5.8
316	70	5.1
324	80	4.5
331	90	4.1
338	100	3.8
344	110	3.5
350	120	3.3

Very full tables may be found in various textbooks.

[TO BE CONTINUED.]

THE WATER SUPPLY OF PARIS—CORRECTION.

On page 13, 2d line from beginning of article for "ground" read "groined;" in 23d line from top of 1st column, page 14, for "miles" read "mills"; in 4th line of 3d column, page 14, for "an air cock" read "air cocks;" in 9th line from bottom of same column, for "31½" read "31½;" in 4th paragraph from top of 2d column, page 15, transpose "1,166,000 and 919,000;" in the 2d paragraph from bottom of same column, read "engines" for "engine;" in 1st line in the 2d paragraph from the top of 1st column, page 16, for "Humboldt" read "Humblot."

THE CANTON (OHIO) CITY WATER-WORKS.

These works were constructed about eleven years ago, the expectation being at the outset that they would cost the city about $75,000. The first water supply was Myer's Lake, a body of water two miles west of the city, nearly a mile long at that time and half as wide. In a short time it became apparent that the lake was inadequate to meet Canton's demand for nature's liquid, and, accordingly, it became necessary to provide a source of supply requisite to the wants of the city. In endeavoring to obtain a good system of waterworks and a pure supply of water, the city has expended upward of $300,000. The source of supply lately has been the west branch of the Nimishillen Creek, but this, the past summer, where dammed for water-works' purposes, has resembled a "dismal swamp," and the water coming therefrom has been pronounced not only impure, but so impregnated with debilitating and otherwise deleterious elements as to be absolutely unfit for use, and it has undoubtedly already exerted a detrimental effect on the sanitary condition of the city. The long-mooted "water-works question" is again before the people, and it is absolutely necessary that the $300,000 already expended be added to. A new house, with an engine of 8,000,000 gallons capacity daily, is being erected.

CLASSIFICATION OF STEEL.

The Société Cockerill, of Seraing, Belgium, arrange their steels into four classes:

1st Class. Extra mild steels. Carbon, 0.05 to 0.20 per cent.; tensile strength, 25 to 32 tons per square inch; extension, 20 to 27 per cent., in 8 inches of length. These steels weld, and do not temper. Used for boiler plates, ship plates, girder plates, nails, wire, etc.

2d Class. Mild steels. Carbon, 0.20 to 0.35 per cent.; tensile strength, 32 to 38 tons per square inch; extension, 15 to 20 per cent. Scarcely weldable, and hardens little. Used for railway axles,

tires, rails, guns and other pieces exposed to heavy strains.

3d Class. Hard steels. Carbon, 0.35 to 0.50 per cent.; tensile strength, 38 to 46 tons per square inch; extension, 15 to 20 per cent. Do not weld, but may be tempered. Used for rails, special tires, springs, guide bars of steam engines, pieces subject to friction, spindles, hammers, pumpers.

4th Class. Extra hard steels. Carbon, 0.50 to 0.65 per cent.; tensile strength. 46 to 51 tons per square inch; extension, 5 to 10 per cent. Do not weld, but may be strongly tempered. Used for delicate springs, files, saws and various cutting tools.—*Abstracts of Institution of Civil Engineers.*

THE DESIGN GENERALLY OF IRON BRIDGES OF VERY LARGE SPAN FOR RAILWAY TRAFFIC.

BY THOMAS CURTIS CLARKE, M. A. S. C. E.; M. INST. C. E.*

Since the year 1863, when the late Mr. Zerah Colburn, M. Inst. C. E., read a Paper on the subject, no communication has been submitted to this Institution relative to the construction of iron railway bridges of long spans, as practiced in America. Although the title of this Paper does not limit its scope to American construction, yet inasmuch as the physical features of American rivers require, and have led to the development of, spans longer than are usual in other countries, it has been thought best to begin by describing American practice, and afterward to generalize so as to to cover the whole subject indicated by the title.

At the time Mr. Colburn's paper was written, the longest iron span in America was the central tube of the Victoria Bridge, at Montreal, 330 feet in the clear. Since then trussed girder bridges have been built up to 515 feet clear span, which is the length of the channel span of the Cincinnati Southern railway bridge, over the Ohio, at the city of Cincinnati, although the span between the masonry is only 500 feet. This is the longest railway girder yet constructed. The Kuilenburg bridge in Holland is the next longest, being 492 feet in clear span. The side arches of the steel bridge over the Mississippi at St. Louis are 502 feet in the clear, and the central one is 520 feet in clear span between the masonry.

All these American bridges are "pin connected," this style of construction being preferred by American engineers for spans exceeding 100 feet, on account of the mathematical certainty with which the strains can be calculated; the ease, celerity, and economy of erection, which for rivers subject to sudden floods is a matter of vital importance; and lastly, because it is believed that the parts of a bridge can be more strongly united in this way than by riveting. Add to this a considerable possible reduction in dead weight of iron over that of riveted construction, and the power of being able to calculate the deflection or camber beforehand with certainty, and reasons enough have been given why this construction is preferred by American bridge designers. The limits of this Paper do not allow of any discussion of the merits of the two systems. Suffice it to say, that in America, bridges exceeding 100 feet span generally have their parts connected by pins; below that length riveted lattice and plate girders are gaining favor, and becoming more and more extensively used, as their size and weight admit of their being transported from the workshops to the place of erection, either whole, or at least in not more than two or three pieces, thus reducing the riveting in position to a minimum. There, are, it is true, a few examples of riveted lattice girders in America up to 180 feet span; but in order to compete with the pin-connected bridges, their designers have reduced the amount of iron far below what is desirable, and their workmanship is much inferior to the best English practice.

Two of the latest and best examples of American long-span iron bridge construction have been chosen for illustration. The channel span of the Cincinnati Southern railway bridge, across the Ohio river at Cincinnati, 515 feet between the points of bearing, is selected as an example of a well designed girder of the type now most approved in America, and erected in the usual manner by temporary stagings of timber. The other example is the bridge of three spans of 375 feet each, carrying the same railway across the Kentucky river. Both these bridges are noteworthy for their economical design, and for their comparatively small amount of dead weight.

According to the American custom the engineer of the Cincinnati Southern railway invited public tenders for both the design and construction of these bridges, furnishing sections of the rivers, with a general specification (Appendix II.) giving the loads to be provided for, and the maximum strains allowed upon the iron. The length of span was left to the designer in the case of the Kentucky bridge, but was prescribed in the specifications of the Ohio bridge. The specifications also provided for a certain quality of iron, and tests were required to be made before entering upon construction. These tests were extended

* A paper read before the Institution of Civil Engineers, May 21, 1878.

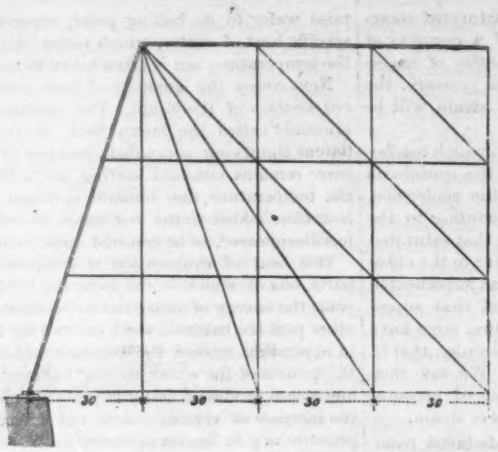


FIG. 1.

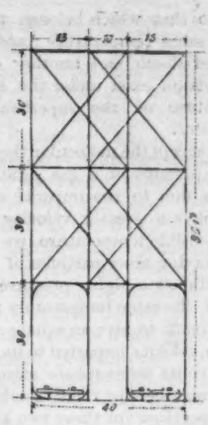


FIG. 2.

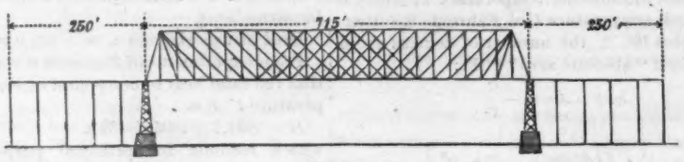


FIG. 3.

Data of weights—

715 feet main girder and piers	4,900 tons.
500 feet viaduct	500 "
	5,400 "

FIG. 4.

Data of weights—

1,215 feet cantilever, including piers and anchorages	4,340 tons.

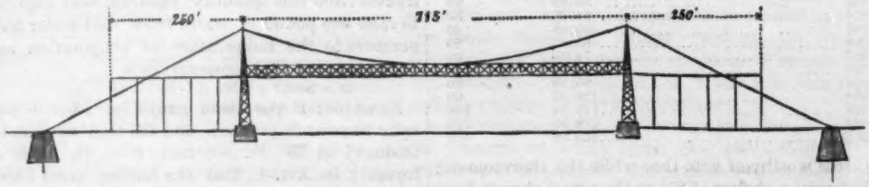


FIG. 5.

Data of weights—

715 feet suspension girder and back chain	3,000 tons.
500 feet viaduct	500 "
	3,500 "

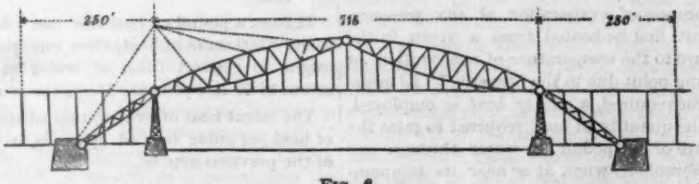


FIG. 6.

Data of weights—

715 feet of arch and shore abutments	2,800 tons.
500 feet viaduct	500 "
	3,300 "

to cover proportions of eye-bars, and the strength of various sections of column-struts, and gave some useful information not accurately known before. The results of these tests will be printed in Appendix III.

The bridges of the Ohio, which is a navigable river flowing past the boundaries of several States, have to be constructed in accordance with Acts of Congress of the United States, fixing their minimum spans and heights, and all the plans have to be approved by the United States engineers. The requisitions laid down by this body demand a channel span of 500 feet in the clear between the bases of the piers, or 515 feet between the points of support, placed at a height of 105 feet above low water in the river, which is 10 feet deep, while the river rises 62 feet in times of floods.

The lower line of staging was erected in December, 1876. The surface of the river was covered with a continuous sheet of ice. A sudden thaw and rise of water of 15 feet washed away the lower staging. Operations were suspended until June, 1877, when the staging was rebuilt. The bottom of the timber trestles stood on the rocky bed of the river. About 500 feet above the line of the bridge a timber crib was sunk and filled with stone. From this a fender of coal-barges chained together was let down to each pier, forming a triangle, of which the crib was the apex and the two piers stood at the lower angles. This fender protected the trestle from being struck by boats or drift-wood, it being arranged to rise and fall with the water.

The ironwork of this channel span of 515 feet had been submerged by a freshet and required washing. The iron was cleaned, elevated 100 feet by steam power, run forward over two spans of 300 feet each, and then hoisted into position by two travelers on the top staging, worked by hand. This was all done in twenty-four and a half working days, by an average force of sixty men. The span was swung clear of its staging by knocking out folding wedges, and then required thirty men for six days more to adjust it, put on cross girders and track stringers, and lay the ties and guard timbers.

The span was tested by running over it seven locomotives and four loaded platform cars, their combined weight amounting to 431 tons.

The centre deflection of the east truss was $2\frac{5}{16}$ inches; the permanent set was $\frac{1}{4}$ inch. The centre deflection of the west truss was 2 inches; the permanent set was none.

The cost of this span was as follows:

	£	s.	£
1,176 tons iron at shop	30	12	36,000
Freight			1,300
Staging	3,500	0	
Erection	600	0	
			4,100
Painting			500
			£41,900

It will be observed that the cost of erection, including staging, is about £3 10s. per ton, while that of the Kentucky River bridge, to be described hereafter, which was erected without staging, was about £2 10s. per ton. Had the Ohio River span been erected without the staging and crib being carried away by the freshet, the cost of its erection would probably have been a little less than that of the other.

This bridge was designed and executed by Mr. J. H. Linville, Member of the American Society of Civil Engineers, who has built five first-class bridges, having channel spans of from 319 feet to 515 feet in length. This last one represents the best practice yet attained, and does great credit to its accomplished designer.

The Kentucky River bridge consists of three spans of 375 feet each, carrying the Cincinnati Southern Railway across a limestone cañon at a hight of 280 feet above the bed of the stream. The piers are of stone to a height of 60 feet, which carries them a little above the highest recorded floods, and of iron for the rest of their height. As the floods are very sudden, it was decided to adopt a plan of construction obviating "false works" or stagings of timber, which might be swept away by freshets, or knocked down by rafts, which pass by during floods at a speed of 7 or 8 miles per hour.

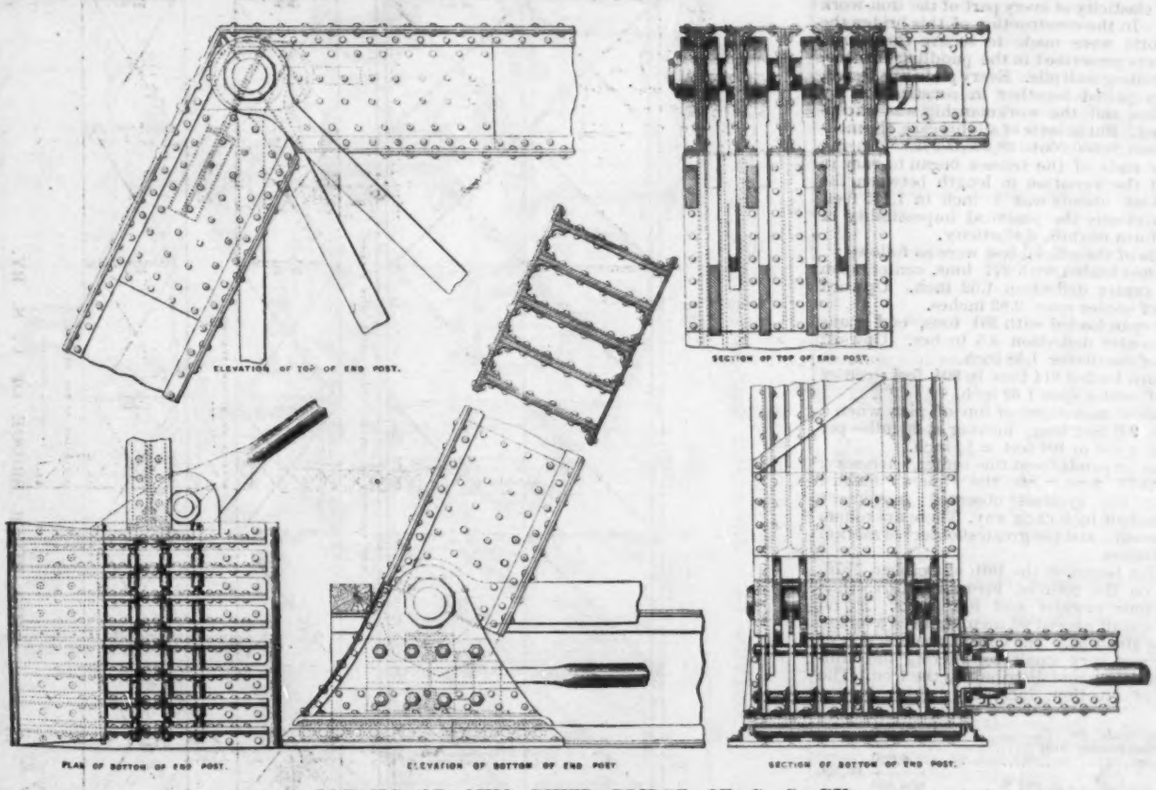
In 1854 the late Mr. J. A. Roebling began to build a suspension bridge, of 1,236 feet span, across this chasm, but the work was abandoned for want of funds, after two towers and two sets of anchorage had been constructed. Mr. C. Shaler Smith, the engineer whose design was adopted, took advantage of the existence of these towers by bolting the first panel of his bridge, on each side, to them, and then corbelling out panel by panel. The towers were calculated to be strong enough to carry 196 feet of projecting spans. At this point temporary towers of wood were built, which gave an intermediate support. The corbelling out process was continued until the shore spans each reached the main iron piers, which were built up simultaneously, so that the two met in mid-air. These piers had been on rollers, as it was impossible to foresee the temperature at which the junction would take place. Each pier, weighing 200 tons, was moved horizontally until a junction was made. Each half of the centre span was then corbelled out as before, until they met in the centre. At this stage of the work, the upper chords being in tension, and the lower in compression, the former were nearer to each other than the latter, the gaps being as follows:

Upper chord,	east gap	3 inches.
" "	west "	2 "
Lower "	east "	4 "
" "	west "	5 "

The gap of 2 inches in the west upper chord was first closed by screw-jacks, which had been placed between the ends of the lower chords and the abutments on the shore spans, and by moving the piers together. This left a gap of $1\frac{1}{8}$ inch between the ends of the east top chord. At mid-day the temperature of the air being 70° Fahr., all the horizontal lateral rods tending to draw these ends together were screwed up and the counter slackened. The contraction of the lateral rods drew the gap together. On the following morning, at a temperature of 40° Fahr., the gap had closed, and the top chord connections were riveted up. The contraction due to temperature had by that time withdrawn the shore ends of the lower chords from the screw-jacks $\frac{3}{4}$ inch. These were then screwed home so as to take up this space, and by midday the lower chords had expanded until the gap in the east chord was closed, which was then riveted up, and by a similar process the gap in the west chord was closed.

It will be observed that up to this time this bridge was a girder of 1,125 feet long, continuous over three spans. But it had been foreseen that a continuous girder would not answer for this situation, because while the abutments on the cliffs were stationary, the iron piers would constantly rise and fall with changes of temperature, and so vary the strains on the web system. It was therefore determined to hinge the shore spans at points 75 feet from the piers, leaving a centre girder 525 feet long, supported by piers 375 feet apart. By this means the shore spans were practically reduced to 300 feet each, one end resting on the abutment, and the other on the overhanging end or cantilever of the centre span.

The final operation, therefore, was to cut the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DETAILS OF OHIO RIVER BRIDGE OF C. S. RY.

lower chords of the shore spans at points previously determined by calculation, at which points tenon joints had been made and temporary rivets inserted. These rivets were cut out, and the mean motion of the several joints was only $\frac{5}{16}$ inch, and the change in the levels barely perceptible. This proves the accuracy of the method used to determine the point of contrary flexure, which was to work out the strains panel by panel, as in calculating discontinuous spans.

To avoid ambiguity in the web strains at the hinging points, both of the web systems of diagonal rods were consolidated into one member at the point of contrary flexure, and separated again after the hinge was passed. When the bridge came to be tested, it was found that the movement of the lower chord tenons under the passing load was 1¼ inches. This shows how great may be the strains concealed in the web system of a continuous girder of large span at the point of contrary flexure. The whole theory of continuous girders depends upon the assumption that the modulus of elasticity of every part of the iron-work is uniform. In the construction of this bridge the greatest efforts were made to secure this. Iron mixtures were prescribed in the puddling furnace, and in the rolling-mill pile. Every plate was tested, and all bars paired together in construction by their modulus, and the workmanship was exceptionally exact. But in spite of all this care, the moduli varied from 20,000,000 to 28,200,000 lbs.* During erection the ends of the trusses began to vary in height, and the variation in length between the east and west chords was 1 inch in 1,125 feet. This shows clearly the practical impossibility of getting uniform moduli of elasticity.

The results of the official test were as follows:

1. End spans loaded with 277 tons, center span unloaded; center deflection 1.52 inch. Upward movement of center span, 2.83 inches.

2. Center span loaded with 331 tons, end spans unloaded; center deflection 3.5 inches. Upward movement of cantilever 1.58 inch.

3. All spans loaded 814 tons in 904 feet; center deflection of center span 1.62 inch.

4. Horizontal movement of top of pier when a heavy train, 90½ feet long, moving at 26 miles per hour, was stopped in 104 feet = ½ inch.

This bridge expands from the center, each way, bending the tops of the piers toward the shores; the greatest observed movement has been one-half inch each way. There are rollers on the abutments, and the greatest observed motion has been 3 inches.

The erection began on the 16th of October, 1876, and ended on the 20th of February, 1877, thus occupying four months and four days. At no time did the staff exceed 60 men, and the average number was about 53. The cost of the erection of this bridge was very small, considering the difficulties of handling and distributing the iron. The total cost of erection, including plant, was as follows:

Cost of making roads, etc.	£2,000	
Hauling and distributing iron	500	
Erection proper	4,000	
		£6,500
Cost of 1,631 tons of iron at £21 7s.	£34,833	
Freight on ditto	3,722	
		45,055
Cost of foundations:		
15,000 cubic yards at 7s. 5d.	£5,573	
Cost of masonry:		
12,635 cubic yards at £2 8s	30,218	
		35,791
		£80,846

The weight of iron was thus distributed:

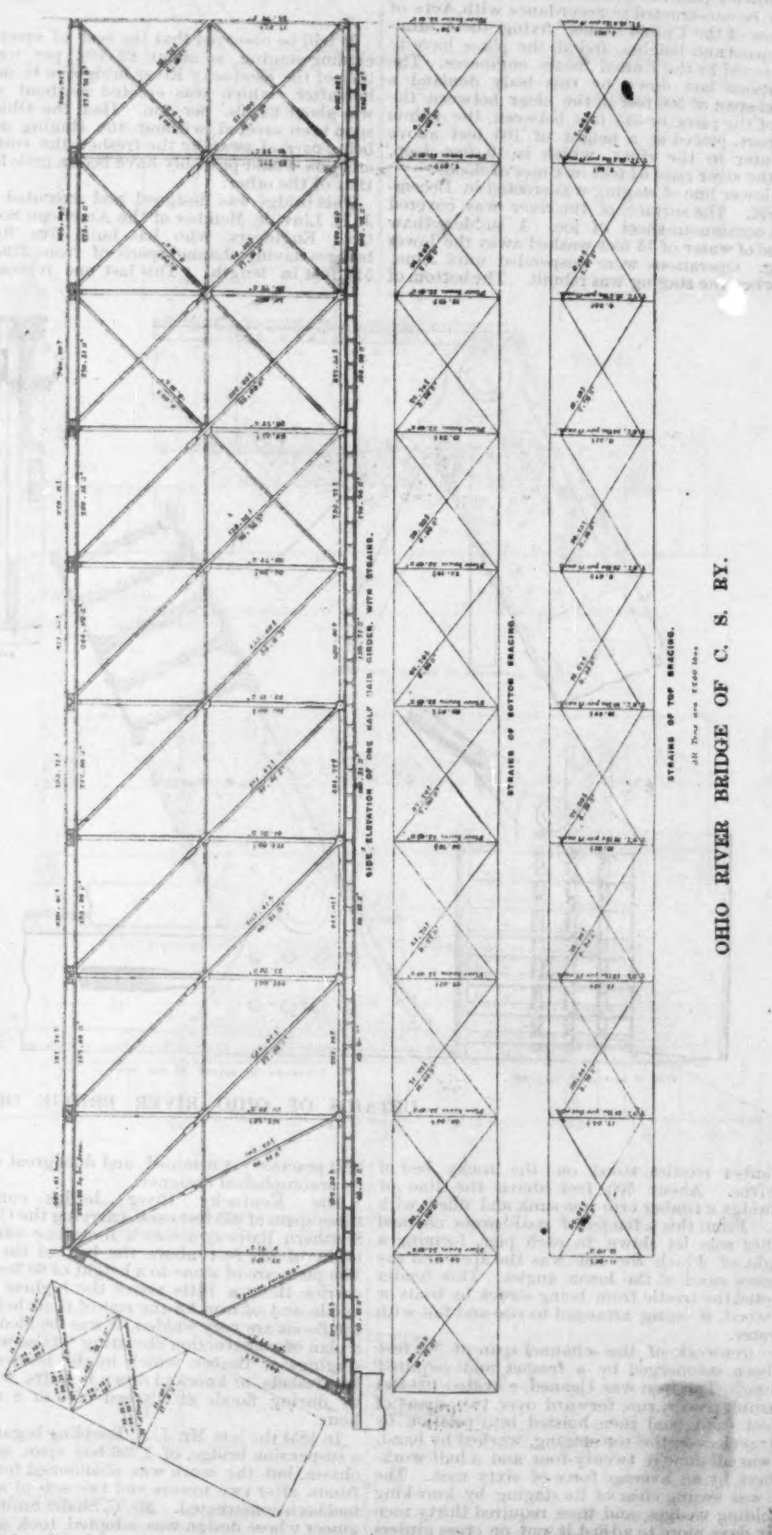
	Lbs.	Lbs.
In 300 feet	716,554	
" 75 " cantilever	230,000	
In 375 feet south span		946,554
" 375 " north "		946,554
" 375 " center "		962,163
" two piers		799,000
		3,654,271

The dimensions are as follows:

Total length of iron-work	1,138 feet.
" " of iron between pier centers	1,125 "
Depth of truss	37½ "
Width "	18 "
Iron pier at base	28 feet by 71½ "
" " top	1 foot " 18 "
Height of pier	177¼ "
Masonry pier	42 feet by 120 feet by 71 " high.
Height of rails above low water	275¼ "
" " " river bed	279½ "
Flood rise	57 "

Seven floods took place during the construction of the bridge, their rise varying from 26 to 47 feet.

This is not only one of the boldest and most original pieces of bridge engineering in America, but, when judged by the crucial test of accomplishing a great deal at the least possible cost, it stands very high among engineering structures all over the world, and its design and execution reflect the highest credit upon its engineer, Mr. C. Shaler Smith, member of the American Society of Civil Engineers.



OHIO RIVER BRIDGE OF C. S. RY.

It has been said that both these bridges were conspicuous for economy of design. Economy of design means the art of getting rid of dead weight. It is of comparatively little importance in short spans; but it is vitally essential in very long ones, as the proportion of dead weight to live load increases in a much higher ratio than the lengths of the spans, even in the best designs. As the limit of span is that distance at which the bridge would break from its own weight alone, the less dead load there is to carry, the farther may that limit be placed.

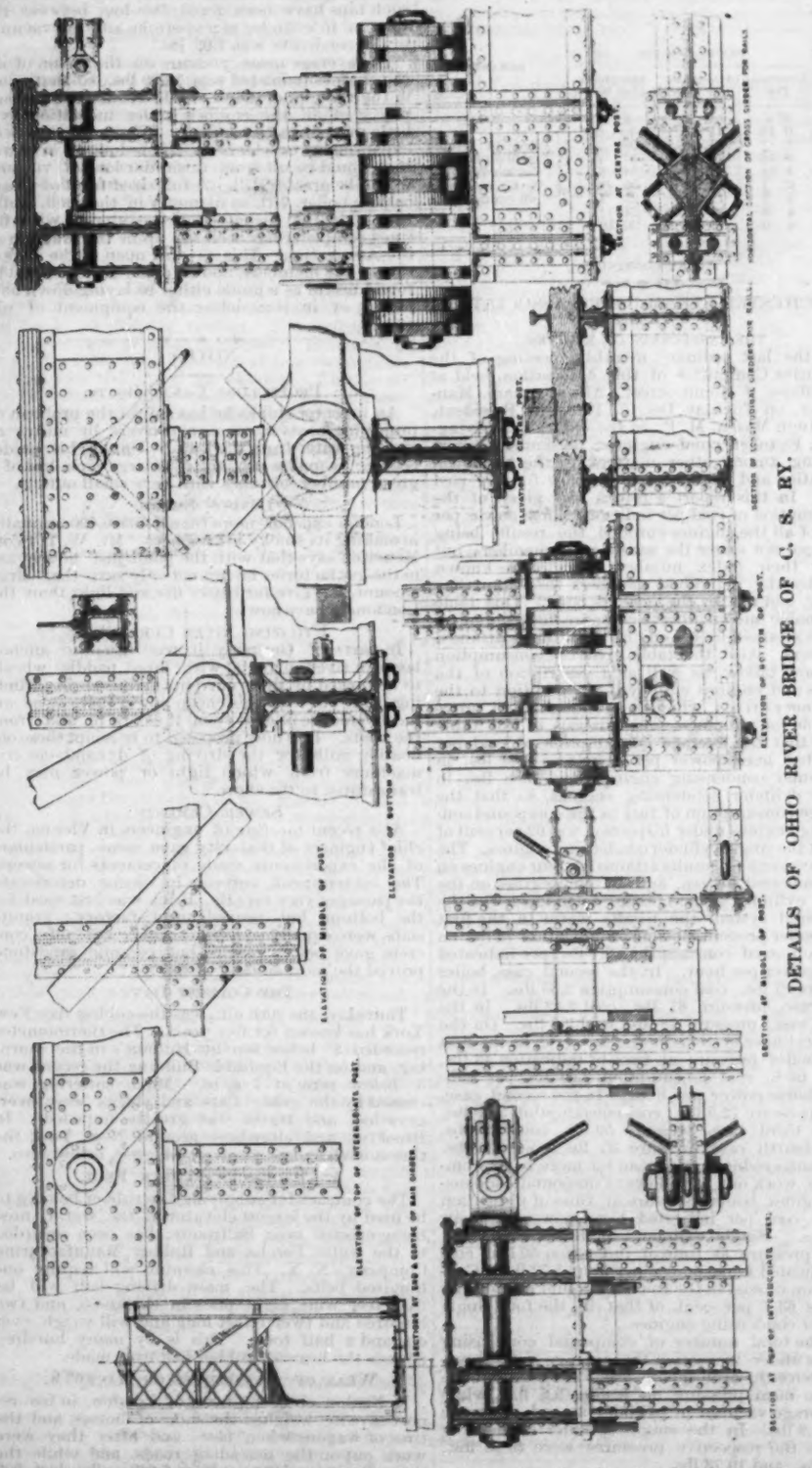
Economy of design is attained by two entirely distinct processes. First by proportioning all the parts of a bridge with a similar factor of safety, and then combining those parts into a whole, so that the structure itself will be as strong as the parts of which it is composed; and secondly, by using such proportions of height of girder, length of panel, and combination of parts; also such width apart between the girders, and such methods of bracing the two into a structure able to resist wind pressure or shocks from [illegible]

* This variation of 40 per cent. is far too great for bars of the same section, and results from the iron having been made at different works, and from different qualities of pig. Bars of similar section, of double refined iron made at Phœnixville from the same ore mixtures, do not vary more than 5 per cent. in their moduli of elasticity.—T. C. C.

trains, as will accomplish the first requisite with the least quantity of metal.

The problem is too difficult to be solved *à priori*, and can only be done by a tentative process. To show how it has been accomplished a table has been prepared (see next issue), giving the weights of iron and other important data of the most conspicuous examples of long span railway bridges constructed in Europe and in America.

In order to see how much dead weight can be saved by judicious design, compare No. 2, Mr. Linville's bridge, built in 1864, of 319 feet span, weighing 484 tons, with No. 4, built in 1870, a bridge of 342 feet span, weighing 338 tons. The older bridge has, it is true, upper chords and posts of cast-iron, and hence is much more massive than if the same members were executed in rolled iron; but a considerable difference of weight also comes from difference of proportion. The older bridge has panels 12 feet 3 inches long, and its height is but $\frac{1}{7}$ of its span. The newer bridge has panels 15 feet 6½ inches long, and its height is $\frac{1}{8}$ of its span.



DETAILS OF OHIO RIVER BRIDGE OF C. S. RY.

Comparing Nos. 6 and 7, No. 6, of 308 feet span, weighs 497 tons; No. 7, of 375 feet span, weighs 425 tons. Here the difference is not due to the height, for the heavier bridge is $\frac{1}{6}$, while the lighter one is $\frac{1}{7}$ of the span. It arises from the unnecessary width of No. 6, which requires a heavier lateral system of bracing, and to four trusses being used where two would have answered, thus making double the number of joints and connections; and dates from the works of Whipple, in 1847, of Bollmann, in 1852, and of Albert Fink, in 1854; while if the Saltash bridge, No. 13, be compared with the Britannia bridge, No. 14, it will be noticed that the greater economy of the former is due to the metal being concentrated along the lines of strain, which is claimed as peculiarly American practice, but it was only introduced by Brunel in 1859.

The Mayence bridge, No. 5, on the Gerber system, is similar to the Saltash bridge, and compares very favorably in weight with the newest American example, No. 4. But the most remarkable difference in the amount of metal used to attain nearly similar results will be seen by comparing the Kuilenburg bridge, No. 15, of 492 feet span, with the Ohio bridge, No. 16, of 515 feet span, which has been described. The dead load of the Kuilenburg bridge, together with a live load of 3,000 lbs. per lineal foot, strains the iron 14,500 lbs. per square inch. Although this bridge carries but one line of rails, it is wide enough for two; to increase the width of the Ohio River bridge to 30 feet would add about 450 tons of iron to its weight. To carry this additional weight and that of a load of 3,000 lbs. per lineal foot would increase the strains on its chord members from 10,000 lbs. per square inch to 13,900 lbs. per square inch; so that it would even then be stronger than the Kuilenburg bridge. The Kuilenburg bridge contains 2,234 tons of metal. The Ohio bridge, 30 feet wide, would have 1,626 tons; 608 tons less than that of a bridge 23 feet less span.

The following table shows the weight of each in detail:

KUILENBURG AND OHIO SPANS COMPARED FOR WEIGHT.

Where used.	Kuilenburg. 492 Feet Span. Tons of 2,240 lbs.	Ohio River. 515 Feet Span. Tons of 2,240 lbs.
Top and bottom members	1,203	594
Diagonal ties	243	102
Posts	340	165
Lateral and wind bracing	208	95
Transverse floor beams	54	49
Longitudinal " "	44	111
Bed plates, rollers, &c	92	30
Total metal	2,234	1,176
Add 8000 cubic feet pine } " 9500 " " fir }	308	Ties, guards, and rails. 60
" plates between rails	350	
Total dead load	2,890	1,236

It strikes an engineer accustomed to American practice with surprise that the designer of the Kuilenburg bridge, apparently not satisfied with the excessive dead weight of the iron-work, has piled upon the structure 656 tons of timber and iron plates. The engineer of the Ohio River bridge was able to confine the weight of the track and guard timbers to 60 tons.

The difference in the weight of the upper and lower members is remarkable, and is owing in a great measure to the arched form of the upper member of the Kuilenburg, which increases the strains toward the ends. The short panels, 13 feet 1 inch, of the Kuilenburg require nearly double as many sets of connections as the 29 feet 9 inch panels of the Ohio bridge; the connections by riveting also necessitate much more dead weight than connections by pins and eyes.

Detailed calculations of strains and weights made by the author have convinced him that the economical limit of a single track iron girder span lies not far beyond 600 feet. The actual limit, beyond which it could be made and have strength enough left after carrying itself to support two locomotives and a train of loaded coal wagons, lies considerably beyond this distance.

The difficulty in designing girders of very long span is to get width enough to resist wind pressure. Such girders require to be very high. The Ohio bridge would be of better proportions if its height had been $\frac{1}{6}$ of its span, or 64 feet. To give it as much lateral stability as it now has, the width in that case should have been 26 feet. This could have been done probably without much increase over its present weight. But add 100 feet to it and preserve these proportions, and the span would be 615 feet; height, 77 feet; width 31 feet. This is about the limit for two main girders.

Suppose the same proportions for a double-track bridge, with four girders of 715 feet span, height 90 feet, width 36 feet, or better 40 feet (Fig. 3), and the cross-sections and side view will be thus (Fig. 1 and 2). Here is a structure possessing lateral stability as well as strength to resist the forces of gravity. The weights of such a bridge for two tracks have been carefully worked out by the

author. They amount to 4,900 tons of metal. The difficulties and risks of erection are very great for such a structure as this; hence it is said that, although practicable, it is not as economical as other forms. These other forms are: Fig. 4, Cantilevers with connecting span. Fig. 5, Stiffened suspension bridges. Fig. 6, Arches.

The suspension bridge, stiffened either by bracing the chains or by a suspended girder, is undoubtedly the most economical structure possible for long spans between towers. Whether it be the most economical *per se*, depends upon whether the banks are high or low. If the banks of the river are as high as the level of the bridge, as at Niagara, it will be the most economical form possible for spans of 700 feet and upward.

The "Point" bridge at Pittsburgh, U. S., of 795 feet span, built in 1877 (E. Hemberle, member of the American Society of Civil Engineers, being the engineer), although a carriage bridge, is strong enough to carry a railway train of 650 tons weight, with a factor of safety of 5. It weighs a little less than 1 ton per lineal foot between the towers.

The Niagara bridge of 821 feet span, built by John A. Roebling in 1855, has its wooden suspended truss badly decayed, and it is proposed to replace it in iron during the present year. Plans have been submitted by a commission of engineers, and if these are carried out the weight of iron between the towers will be a little more than 800 tons. It will then be able to support a railway train of 500 tons with a factor of safety of 4.

Where the banks are low, the increased length of the back chains will add to the cost, and other forms may be preferable.

The cantilever, with connecting span, will never, under any circumstances, be as economical of metal as the stiffened suspension bridge. It shares with it the defect of having its stability dependent upon anchorage built in masonry, and practically inaccessible. Its continuity being cut in the center, it has to be very wide in order to resist wind pressures, which in long spans become an important factor in modifying the shape of the structure. No large cantilevers have yet been built, and their success on an extensive scale is problematical.

The arch bridge remains, and that form consisting of two lunettes hinged at the center, invented by James B. Eads, M. Inst. C. E., appears to possess many advantages. Where the headway required allows of its being placed below the track of bridge, its economy becomes manifest. Where it is all above the line of rails, and where the banks are low and the level of rails high, its economy is greater than that of almost any other form, as it reaches the points of support sooner than any other form can do.

To illustrate this point, estimates of weights have been made for a double line of rails with a moving load of 3,400 lbs. per foot, wind pressure 40 lbs. per square foot, iron to be strained 10,000 lbs. per square inch, length of spans 715 feet, height above the level of the shore 100 feet. The weights include two iron piers, and 500 feet of viaduct have been added to Nos. 1, 3, and 4, to equalize them in length with No. 2.

The erection of the suspended girder would not be difficult, and no staging would be required. The same may be said of the cantilever, and of the Eads arch, which would, for the purposes of erection, be temporarily made into a cantilever by erecting a timber tower, and suspending it by iron tie rods, as shown by the dotted lines. The erection of the quadrangular girder would always be expensive, and probably involve much risk. In some places it would be impossible.

Nothing has been said in reference to economizing weight by the use of steel. At present its cost is too high, and its strength is too variable. When more is known about steel, it may be used in very long spans. All the compressive members in designs 2, 3, and 4 might be made of steel with economical results, and its use in them would require no new process of manufacture. Steel eye bars have not yet been made, at least to the knowledge of the Author.

The workmanship of long span bridges in the United States is generally first class. All abutting surfaces are planed, bored, or turned. The limit of error in links is $\frac{1}{64}$ inch, which is attained by drilling both holes at the same time on a machine whose bed is of wrought iron, hence expanding equally with the bar. Eye bars are proportioned by rules derived from many experiments. A Paper read by C. Shaler Smith, Member of the American Society of Civil Engineers, gives the latest and best practice. Holes are punched, and riveting is done by steam or hydraulic power, and three hundred rivets per hour is not an unusual performance. In riveting at the site, the holes are punched small, and reamed and drilled to the proper fit.

The price of bridge work in the United States has fallen every year with the lower price of iron. The following table gives an approximation to the prevailing rates for American pin-connected bridge work:

Year.	PRICES PER TON. American Pig.	American Bar Iron.	American Bridge Work.	REMARKS.
	£ s.	£ s.	£ s.	
1870.	6 13	15 16	40 6	
1871.	7 1	15 14	38 2	
1872.	9 16	19 10	37 7	Prices of riveted lattice plate girder work £2 10s. to £3 less than pin-connected.
1873.	8 11	17 6	34 7	
1874.	6 1	13 12	30 10	
1875.	5 2	12 4	27 4	
1876.	4 9	10 5	24 11	
1877.	4 0	9 10	20 16	

(TO BE CONTINUED).

MANCHESTER STEAM USERS' ASSOCIATION.

THE INSPECTION OF ENGINES.

At the last ordinary monthly meeting of the Executive Committee of this Association, held at the offices, 9 Mount street, Albert square, Manchester, on Tuesday, Dec. 7, 1880, the President, Mr. Hugh Mason, M. P., in the chair, Mr. Lavington E. Fletcher, chief engineer, presented a report alluding, among other matters, to the periodical indication and inspection of engines for the past year. In this report a return was given of the consumption of coal per indicated horse-power per hour of all the engines enrolled, the results being arranged not under the names of the members, but under their index numbers, which are known only by the individual members to whom they belong, and not by the general body. This table will enable one member to compare the economical results attained by his engine with those attained by others. Also, this table gives the consumption of oil and tallow, as well as a description of the boilers and engines employed, in addition to the machinery driven, which it is thought will prove valuable for reference. An analysis of this table shows that the average consumption of coal per indicated horse-power per hour was 3.66 lbs. in compound condensing engines, and 5.88 lbs. in single cylinder condensing engines, so that the average consumption of fuel in the compound condensing engines under inspection was 62 per cent of that of the single cylinder condensing engines. The most economical results attained in four engines on the compound system, and in four engines on the single cylinder system, were as follows: On the compound system the results were: In the first case, boiler pressure at time of indication 73 lbs. on the inch, coal consumption 2.1 lbs. per indicated horse-power per hour. In the second case, boiler pressure 81 lbs., coal consumption 2.35 lbs. In the third case, pressure 61 lbs., coal 2.42 lbs. In the fourth case, pressure 78 lbs., coal 2.6 lbs. On the single cylinder system the results were: In the first case, boiler pressure at time of indication 43 lbs. on the inch, coal consumption 3.24 lbs. per indicated horse-power per hour. In the second case, boiler pressure 72.5 lbs., coal consumption 3.69 lbs. In the third case, pressure 59 lbs., coal 3.85 lbs. In the fourth case, pressure 35 lbs., coal 4.11 lbs. The results reduced to a mean for more ready comparison work out as follows: Compound condensing engines, boiler pressure at time of indication 73 lbs., coal per indicated horse-power per hour 2.37 lbs. Single cylinder condensing engines, boiler pressure at time of indication 52 lbs., coal per indicated horse-power per hour 3.72 lbs. Consumption of coal in the four compound condensing engines 63.7 per cent. of that in the four single cylinder condensing engines.

In the total number of compound condensing engines under inspection the average initial pressure above the atmosphere was 55.82 lbs., and the average mean pressure on piston 19.8 lbs., while the average vacuum in cylinder at end of stroke was 11.2 lbs. In the single cylinder condensing engines the respective pressures were 26.23 lbs., 17.18 lbs., and 10.73 lbs.

Turning to the temperature of the condensing water and degree of vacuum attained in all the engines indicated, the report stated that the average temperature of the injection was 60.89 deg., ejection 95.72 deg., giving a rise of 34.83 deg., while the average vacuum was 9.87 lbs. at the beginning of the stroke, and 11.04 lbs. at the end of the stroke, giving a mean of 10.45 lbs. The highest vacuum attained in any one case was 12,77 lbs.

In 34 engines in which the temperature in the hot well was not less than 100 deg., the average vacuum was 10.28 lbs. at the beginning of the stroke, and 11.48 lbs. at the end of the stroke, giving a mean of 10.88 lbs.

The report recommended that taps should be fixed to the condensers to allow of an indicator being applied so as to check the accuracy of the vacuum gauges. In the twenty engines to which such taps have been fixed, the loss between the vacuum in cylinder at mid-stroke and the vacuum in the condenser was 1.09 lbs.

The average mean pressure on the piston of all the engines indicated was 18.89 lbs., so that a loss in the vacuum of 2 lbs. would reduce the average power of all the engines under indication by a little more than 10 per cent. Where the degree of expansion is considerable, the reduction in power that would result from a similar loss of vacuum would be greater still. A full-sized front of a Lancashire boiler, 7 ft. in diameter in the shell, and 2 ft. 9 in. in the furnace tubes, equipped with fittings complete, has been set up in the museum of the Association. This is now open to the inspection of the members, and an examination would be found useful as a guide either in laying down new boilers or in remodeling the equipment of old ones.

NOTES.

PROPELLING CANAL BOATS.

An inventor thinks he has solved the problem of propelling boats in canals and rivers by means of ejecting water from the boat. Unlike his predecessors, he makes use, not of a large pipe, but of a great number of tubes with very small outlets.

LONDON SMOKE.

London expends more than $10,500,000 annually in making its smoky atmosphere. Mr. W. D. Scott Moncrieff says that with the plant just now in use in the gas factories he can not only save that large amount, but give far better fire and light than the Londoners have now.

UTILIZING RIVER CURRENTS.

In parts of Germany it was usual to anchor boats in river currents, with large paddle wheels to be turned by these currents and used in grinding corn, but with this cheap power there was an inconvenience in conveying the corn to and from the boats. It is now proposed to re-adapt these old floating mills for the driving of dynamo-electric machines from which light or power may be transmitted to the shore.

SEWER CEMENTS.

At a recent meeting of engineers in Vienna, the chief engineer of that city gave some particulars of the experiments made on cements for sewers. The subterranean currents in Vienna deteriorate the passages very rapidly. Brick was first used for the bottom, but proved unsatisfactory; granite slabs were equally so as the corners wore off; concrete gave better results, but ceramic sandstone proved the most suitable of any.

THE COLDEST DAY.

Thursday, the 30th ult., was the coldest day New York has known for five years. The thermometer recorded 2° below zero at Hudnut's in the morning, and on the Equitable Building the record was 5° below zero at 7 a. m. Much suffering was caused by the cold. Cars and stages were overcrowded, and travel was greatly impeded. In Brooklyn and elsewhere around New York the thermometer marked several degrees below zero.

AN ENORMOUS RUBBER BELT.

The contract for supplying the rubber belting to be used by the largest elevator in the world, now being erected near Baltimore, has been awarded to the Gutta Percha and Rubber Manufacturing Company, N. Y. This elevator will require one hundred belts. The main driving belt will be five feet wide, eight plies in thickness, and two hundred and twelve feet long and will weigh over one and a half tons. This is by many hundred pounds the heaviest rubber belt ever made.

WEAR OF HORSESHOES ON MACADAM.

McNeal, a civil engineer, of London, in his report says he weighed the shoes of horses and the tires of wagons when new, and after they were worn out on the macadam roads, and while the tires of wagons in traveling 6,048 miles lost 300 pounds, the shoes of the horses lost 360 pounds. The saving in the lives of horses in favor of wood he finds is five to two, and the saving in the wear and setting of shoes is at least one half; or, in other words, it costs twice as much to keep horses shod on stone pavements as it does on wood.

VENTILATION OF SEWERS.

A paper was recently read on this subject, before the Scottish Society of Arts. The writer, after enumerating the various causes for the escape

of sewer gas; storms, the tidal wave, and, even the change of temperature—proposed the following remedies: unsealing the street gullies, erecting shafts or introducing open street gratings. Sewer ventilation must admit of the ready escape of gas, the entrance of sufficient air to dilute it, and give such an aeration of the main sewers as to oxidize any foul matter in the main sewer.

THE SIEMENS-MARTIN STEEL.

The Siemens-Martin steel is greatly used in shipbuilding and boiler-making. Mr. Sergius Kern, of St. Petersburg, states that in the manufacture of plates he has noticed that the Siemens-Martin ingots stand a better heat and roll more softly than Bessemer ingots containing the same quantity of carbon. Moreover Siemens-Martin ingots contain, as a rule, less manganese than Bessemer ingots, and as plates containing much manganese are more liable to oxidize, the Siemens-Martin plates are preferable for the above-mentioned purposes.

RAPID TRANSIT IN BOSTON.

The elevated railway question will again come up for consideration before the Massachusetts Legislature at the coming session. The defeat last year has seemed to whet the ardor of the projectors of the scheme, and instead of one corporation three or four will apply for charters. This question is assuming proportions alarming to those owning real estate on some portions of the proposed routes. The experience of New Yorkers in the lower part of their city does not tend to increase the desire of Boston merchants to have their stores darkened, and the privacy of their dwellings invaded by the curious eyes of passengers. Some who own practically useless tracts of real estate in the suburbs see in the elevated railway a medium by which the value of their estates can be increased many fold, and naturally enough they are found among the advocates of rapid transit.

MINERAL WOOL PACKING.

In many cases steam pipes that were wrapped with mineral wool (slag wool) have become deeply rusted. It was at first suspected that the gypsum was the cause of the corrosion of the iron, but a careful analysis has shown that there were no sulphur salts, and it is now supposed that the rusting was due to the hygroscopic character of the wool. The following plan has been contrived for remedying the evil: Two parted cast-iron muffs are screwed upon the ends and in the middle of each tube, which serve as receptacles for wooden laths. The space between these and the tubes is packed tightly with the wool, about five centimeters (1.97 inch) thick, and the whole is wrapped at various places with iron wire, so that the envelope is bound fast to the tube. The laths are first soaked in tar, and the wrapping is also varnished with tar and then surrounded with a shell of sheet-iron, which is also wound at different places with iron wire. The ends of the shell are placed in the muffs, and those are also coated with tar.—*Dingler's Journal.*

THE LONGEST TUNNEL IN THE WORLD.

The Joseph II. mining adit, at Schemnitz, Hungary, begun in 1872 and finished last October, is now the longest tunnel in the world. Its length is 16,538 meters, that of the St. Gothard tunnel being 14,620, and the Mont Cenis tunnel 12,233 meters. The object of the adit is the drainage of the important gold and silver mines at Schemnitz. It furnishes a geological section more than 10 miles in length and gives not only valuable information as to the downward prolongation of the lodes known in the upper levels, but some new ones have been traversed, and the entire series of rocks, with their mutual limits, as well as modifications and occasional transitions, are disclosed without interruption. The entire cost of the tunnel was 4,566,000 florins—about $2,300,000. Its height is three meters; width 1.6 meters.

A NEW THERMOMETER.

Professor Dufour, of Paris, has arranged a thermometric apparatus which shows the changes of temperature in a very marked way. The mere approach of the hand to the bulb will throw a needle over the whole of a graduate arc. The device consists of a bent tube, having a bulb at one end, coated on the outside with lampblack. The middle of this tube is filled with mercury, and is supported by arms nicely pivoted. Above the pivot is fixed an index needle, which moves across a graduated arc, and beneath the pivot hangs a rod, to which is attached by friction a small weight, which serves to balance the needle so as to make it point to zero on the arc. When the temperature rises in the slightest degree, the heat being readily absorbed by the lampblack on the air-bulb, drives the mercury forward and displaces the center of gravity so that the needle turns at once toward the right. When the bulb is exposed to a decrease of temperature, the needle points toward the left. So sensitive is this apparatus to changes of temperature, it has been necessary, to check its sudden tipping over when exposed to a rather high heat very quickly, to place two fixed pins at convenient points beneath the tube.

THE MARINER'S COMPASS.

In the Royal Library of Paris there is an Arabian manuscript, written in 1242, by Bailac Kipdjatie, which describes the sea-compass of that period as follows: "We have to notice, among the properties of the magnet, that the captains who navigate the Syrian seas, when the night is so dark as to conceal from view the stars which might direct their course according to the position of the four cardinal points, take a basinful of water, which they shelter from the wind by placing it in the interior of the vessel; then they drive a needle into a wooden peg or a cornstalk, so as to form the shape of a cross, and throw it into the basin of water prepared for the purpose, on the surface of which it floats. They afterward take a loadstone of sufficient size to fill the palm of the hand, or even smaller, bring it to the surface of the water, give their hands a rotary motion toward the right, so that the needle turns on the water's surface; they next suddenly and quickly withdraw their hands, when the two points of the needle face the north and south. They have given me ocular demonstration of this process during our sea voyage from Syria to Alexandria in the year 640 (1242 A. D.)" The manner of communicating magnetism to a needle made to float on the water, "so as to form the shape of a cross," as described by the Arab, is worthy of notice. There is magic as well as superstition in it. Raymond Tully, of Majorca, an ingenious and eccentric man, himself a skillful mariner, in a nautical treatise entitled "Fenix de las Maravillas del Orbe," written in 1286, has furnished proof that it was not then unknown to him. He remarks that the seamen of his time employed "instruments of measurement, sea-charts and the magnetic needle." In Christian Europe the first mention of the use of the magnetic needle occurs in a politico-satirical poem, called "La Bibia," by Guyot, or Guiot, of Provence, written in 1190, full 112 years before the time of Amalfi, the Neapolitan. This interesting poem is contained in a curious quarto manuscript of the thirteenth century, on vellum, belonging to the Royal Library at Paris. The author, Guiot de Provence, was at the court of the Emperor Frederic Barbarossa (as mentioned in the poem itself), held at Mentz in the year 1181, when the Emperor's two sons were knighted.—*Rear Admiral Preble—The United Service.*

TEMPERATURE OF DEEP SEA WATERS.

From a comparison of the results of recent deep-sea soundings, it appears that the following are just generalizations: 1. The water of the North Pacific is in its whole mass cooler than that of the Atlantic. 2. The water of the South Pacific is, down to 4,225 feet, somewhat warmer than that of the Atlantic, but below that depth colder. 3. The bottom temperatures are generally lower in the Pacific than in the Atlantic at the same depths and in the same degree of latitude; but nowhere in the Pacific are found such low bottom temperatures as in the Antarctic portion of the South Atlantic, where temperatures of—0.3° Centigrade to —0.6° have been measured. 4. In the western parts of the Pacific and the adjoining parts of the East Indian Archipelago the temperature of the water reaches its minimum at depths between 1,787 and 8,937 feet remaining the same from this depth to the bottom. In the whole of the Atlantic the temperature from 8,937 feet to the bottom gradually though slowly increases.

GENERAL INTELLIGENCE.

☞ *We solicit and are always pleased to publish in these columns any items of interest that may be furnished us.*

GAS AND WATER.

The total pumpage of the Philadelphia water department for last year was 19,894,101,515 gallons, the average daily pumpage being 54,707,815.

Boston is much troubled over the inadequacy of its water supply, Mystic Lake, from which it mostly comes, being so dry that a large part of its bed is exposed, but it is thought that the engines will be able to pump up a sufficient amount until the Spring thaws begin.

The Holly Manufacturing Company has filed a bill in the United States Courts, to restrain the City Water-works Company, of Omaha, Nebraska, from infringing upon their patents. The original specifications were drawn in accordance with the Holly system—pumping direct into the mains—and can only be executed by them.

The capacity of the new St. Joseph (Mo.) Water-works for throwing fire-streams was tested by the City Council on the 10th inst. The works are built upon the reservoir plan, the reservoir being at an elevation of 310 feet above the Missouri river. The pressure is by gravitation alone, and streams thrown from fire-hydrants in various parts of the city varied from 100 to 175 feet.

The sub-committee of the Allegheny (Pa.) Water Committee, accompanied by City Engineer Ehlers and Water Assessor Grier, recently examined the property on Henderson's, Nunnery, Observatory and McCreery's Hills, and found 395 houses are in need of water. The plan proposed for supplying the water is to locate a boiler-house and pumping-engine on Howard street, at Elm street, and pump from the water-main at that point to an iron water-tank, to be located on the highest point of Nunnery Hill. It was suggested that two tanks be put up—one on Nunnery Hill and the other at a point not so high, the latter tank to supply the lower districts. Each tank will have a capacity of from eighty to one hundred thousand gallons. In order to supply the water to the dwelling houses about 25,000 feet of pipe, from four to ten inches in diameter, will be necessary. The estimated cost is put at $30,000, and the annual revenue from water rents is estimated at $4,500. The committee adjourned to meet on Saturday night, when City Engineer Ehlers will have the plans and estimates prepared.

The following items are taken from the Mayor of Boston's message to the City Council: "During the past year the board of water commissioners has been reorganized. It now consists of the mayor and two citizens elected by the city council, and the city engineer is clerk of the board. There are now over 1,200,000,000 gallons of water in the Ludlow reservoir, probably more than a year's supply, and the quality of the water improves with each year. For construction there was a net expenditure of $8,135. The total cost of the works to Dec. 1 was $1,216,847, and the balance in the city treasury, to the credit of the commissioners, was $918. During the year the water mains were extended 6,650 feet, of which 5,520 feet were on the high and 1,130 feet on the low service, which includes the transfer of quite an amount of pipe from Wason avenue and the line of the Boston and Albany railroad to Worthington street, this being the principal improvement of the year. We find the receipts were $82,931, from which, deducting cash on hand and expenses $14,780, leaves a balance of $68,151. This amount has been paid into the treasury toward paying the $82,000 interest on the water bonds, leaving a deficiency of $13,848. As the total water rent charged in 1880, exclusive of water used by the city, was only $65,702, with a probable net result of $62,100, from which must be deducted $10,000, the cost of maintenance, we cannot count on a probable net income for 1881 of over $54,000. This would leave $28,000 to be raised by taxation to meet the interest on the water bonds. There was due the department December 10, 1879, $18,388, and on the same date, 1880, the amount due was only $1,427. The commissioners recommend an appropriation of not less than $10,000 for purposes of construction in extending the high service mains."

The Committee on Judiciary (Chicago) held a meeting on the 8th, in the city clerk's office. After considering some minor matters, the question of the proposed new water-works came up. Ald. Clark stated that he believed that by the time the new works were built the city would be lighted by electricity, and that pumping-works in the various parts of the city would be used to furnish the power. The committee agreed with Mr. Adams, corporation counsel, that the city had the power to construct additional water-works, and resolved by a unanimous vote to report as follows to the Council, Monday evening:

Ordered, that the commissioner of public works is instructed to employ, subject to the approval of the Council, an engineer of the highest reputation and character, to prepare full plans and specifications for two pumping engines, each to have a capacity to raise 18,000,000 American gallons every twenty-four hours 125 feet. That upon the acceptance of said plans by the Council, the said commissioner of public works is instructed to advertise for thirty days in such of the Chicago morning papers, and such papers in other cities, as he may deem expedient, for proposals for the erecting of said engines, with boilers and connections complete, and submit said proposals to the Council. Upon the approval of any proposal by the Council, the commissioner shall advertise for proposals for a sale to the city of a site to be occupied by a City Water-works on the east bank of the South Branch of the Chicago River, between Polk and Monroe streets, of not less than 60,000 square feet. That the said commissioner, in connection with the city engineer, after the purchase of said ground, as soon as practicable, shall connect the pump wells to be constructed thereon with the water tunnel leading to the West Side Pumping-Works. The said branch tunnel and connections, and the buildings and the erections at said proposed new site, to be arranged, so far as practicable, for supplying additional pumping-engines of equal capacity with those herein named, so as to meet future demand. It is further

Ordered, That the cost of said land, plans, engines, boilers, tunnels, and other work authorized by this order, shall be paid for out of any moneys to the credit of the water fund, not otherwise appropriated.

ELECTRICITY.

A telephone line has been completed between Providence and Boston, and was opened this week.

BRIDGES.

The Chicago, Milwaukee & St. Paul Company are building a new iron draw-bridge over the Kinnickinnic River, to take the place of the one now standing. It will be a first-class bridge, with double track, and will cost in the neighborhood of $30,000 or $40,000. The stone piers and abutments are already finished, and Monday trains will be run across a temporary structure, near the old one, until the new one is completed.

The Corrugated Metal Company, of East Berlin, Conn., which contracted with the city authorities of Manchester, N. H., to erect an iron bridge over the Merrimack River, just north of the Stark Mills, are busy in putting up the structure, and the managers hope to complete the work early in March next. It is a double deck four truss bridge, 1,100 feet long and 40 feet wide. About 600 tons of iron will be required in its construction. It will be one of the longest and strongest bridges in New England. The contract price is $67,000. The structure is required to connect the main portion of the city with the large track of land on the west side of the river, owned by the Amoskeag Company, upon which it is expected that a very large number of dwelling houses and other buildings will be erected within a short time. The company has already sold about forty house lots, each 100 feet deep by 50 front.

RAILROADS.

It is stated that the North Pacific railroad will be completed in 1883.

Nearly $1,000,000 have been raised in St. Louis to aid in the construction of the St. Louis & Texas narrow-gauge railroad.

It is said that the Chicago, Milwaukee & St. Paul Company will iron the grade between Sioux Falls and Dell Rapids, Minn., this spring.

The contractor for building the Haddonfield & Marlton Railroad has finally been compelled to succumb to the weather and has discharged all his workmen.

Twelve new passenger coaches have just been purchased by the Chicago & Northwestern Company. One is to be placed on each train of the Milwaukee Division.

The total mileage of railroads terminating at Council Bluffs is over 140,000. The receipts of cattle alone were 124,012 head; sales, 89,760 head; showing an increase of 72,760 head in sales, and 8,764 in shipments.

The survey for the extension of the Milwaukee & Northern Railway to Lake Superior has progressed favorably, notwithstanding the inclement weather and grading, and ironing will commence early in the spring.

The surveys of the Illinois River road, which is the extension of the I., B. & W., from Pekin to Peoria, Illinois, has been completed, and the construction of the road is to be commenced immediately. The rails, cross-ties, etc., have been purchased, to be delivered within sixty days.

The track of the Chatteroi Railway, building from Ashland, Ky., to the Peach Orchard coal mines, in Lawrence County, Ky., on the Big Sandy River, reached Louisa, Jan. 6, having accomplished a distance of thirty-one miles, and eight more miles will take it through to its present destination.

The Sioux City & Pacific railroad is now crossing on its ice bridge at Blair material for 200 miles of new track, to be built next season in Nebraska and Dakota. Of this new track 25 miles will be an extension to Niobrara. The other 175 miles will be an extension of the main Elk Horn line toward the Black Hills

The construction party on the New York & New England Railroad is within three miles of Brewsters, N. Y., and the bridge across the Croton is nearly ready for the rails. The 6 per cent. mortgage bonds of the company, to the amount of $1,000,000, recently sold at 100½; showing a decided improvement in credit.

GALVESTON, Texas, Jan. 8.—A dispatch from Palestine, Texas, says: "The corps of engineers of the Great Northern Railroad are now organized, and will start on Monday night to make a preliminary survey of the road from Laredo to the city of Mexico. The road will be rapidly constructed from San Antonio to the Rio Grande, most of which is now under contract."

The argument upon the application for a preliminary injunction by the Commonwealth of Pennsylvania, and the board of inspectors of the Western Penitentiary, to restrain the Pittsburgh & Western Railroad Company from constructing their railroad through the Penitentiary property, took place in the Pittsburgh Courts, on Friday, Jan. 7. A plan showing proposed location was submitted by Mr. Emile Low, the company's chief-engineer. This case excites considerable interest, as it is the first of the kind ever tried in a Pennsylvania court. Both sides were represented by the best legal talent of the city of Pittsburgh. A decision will be rendered in a few days, which is anxiously looked for.

The track of the Texas & Pacific Railroad is now laid (Jan. 1) to section 121, being 150 miles west of Ft. Worth, and at the east edge of Taylor county, Texas, on an altitude of 2,000 feet above sea level at Galveston. The grading is completed 100 miles west to the Staked Plains (Llano Estacado), across which, for 100 miles farther, no grading is required. Grading will also be commenced at El Paso and come east to connect at the Gaudalupe Mountains, so as to have the whole line completed by January next. The contractors for the 500 miles of track laying are Coleman Brother, of Madison, New Jersey, being the three brothers James, Mike, and Peter Coleman, so well known in New Jersey and New York railroad circles as contractors of large experience and capital. They are working here 200 men and 40 teams, and are able to put the track through to El Paso on time. Abilene, the end of the Brazos division, is 10 miles west, and will be the "future great—"

The business of the Western Wheel Scraper Company, advertised elsewhere in this journal, is growing so rapidly as to compel it to make additions to its buildings and add new machinery to enable it to meet the demands of the increased business. It has been making some large shipments to Texas within the last month, and is expecting more large orders from that state. All the principal contractors in Iowa, Nebraska, Illinois, Minnesota and Wisconsin, are now using the wheeled scrapers and plows with success. This company is also preparing to manufacture a new drag scraper. It is to be made entirely of steel similar to the body of the wheeled scraper, has an extra bottom, or shoe, which takes all the wear. This shoe can be easily replaced (extra ones being furnished with the scraper when desired) by one who can use the hammer, and need not be taken out of the pit for the purpose. It is furnished with a bail with a swivel for attaching the doubletreed so that they can be dumped sidewise like a common chain scraper.

RIVERS AND HARBORS.

The men in the employ of the government are at work surveying the channel to the river. They have commenced at a point outside of where the can buoy is anchored in summer, and will work in toward the river's mouth. Their work outside will take probably three weeks, when they will survey the river at the points needing improvement. The bar opposite Roberts' wharf, Bradley's bar, and possibly Rust's bar, will be removed.—*Bay City, Mich., Tribune.*

CANALS.

ST. CATHERINES, Canada, Jan. 10.—The work to complete the enlargement of the Welland Canal, so that the promised opening for navigation may take place by midsummer next, proceeds apace. On Saturday the timbers for the guard-lock gates were started up the line, and will at once be put in place. This will permit of the watering of the lower levels, and the gates for the other locks can be floated to their respective places when ready. The contractor for the main bridges is also vigorously pushing forward his work, and has now two bridges about ready to be swung. Tenders will at once be asked for the service bridges at each of the regulating weirs and over the water-ways, through the tow-paths, and for the mooring and snubing posts. The chief engineer, Mr. John Page, has been here for some days giving personal attention to the matter noted above, and adheres to his determination to open the canal at the time promised.

The chief engineer of the Illinois & Michigan Canal, D. C. Jenne, has completed his estimates of the cost of the construction of the feeder connecting the Desplaines River with the canal at a point below the guard-lock at Summit. He states he found the surface of the river seven and one-half feet above the surface of the water in the canal, and the whole lay of the ground favorable for the project. The length would be about 1,000 feet, and the bottom forty feet wide; the sides, with a slope of one to one, and riprapped and cut to a depth of three feet below the surface of low water in the river. The total estimate of the work, including engineering and the provisional 10 per cent., is $9,713; the actual estimate, $8,830. He also states, by putting in a bulk-head, at a cost of not more than $2,000, all ice and pond privileges on the canal will remain unimpaired. The report covers the ground fully, and a bill will be presented to the legislature to authorize the work and making an appropriation for the same. Mr. Jenne reports that this feeder will purify the canal and Illinois River. At the same time it will compel the city of Chicago to make some different disposition of its offal.

NEW PROJECTS.

Leadville is to be connected with Denver by telephone.

The Duluth Chamber of Commerce is now agitating for a canal to connect Lake Superior and Red River.

The New Orleans & Texas Pacific Railroad Company has purchased two squares of ground in New Orleans for $150,000. This will be the site of the new depot, and it is stated that $2,000,000 will be expended in depots, workshops, etc., in the city.

It is stated that a scheme for the construction of a grand eastern railway from Pesth, through Belgrade to Constantinople, under international auspices, has been submitted to the Austrian and Servian governments and to a great London financial firm.

The contracts for building the Baltimore, Cincinnati & Western Railway will be closed this month and work begun early in February. The road will be 571 miles long, and the grade in West Virginia will not be more than seventy-five feet to the mile, while there will only be two tunnels.

CATSKILL, N. Y., Jan. 8.—The South Cairo & East Durham Railroad Extension Company of the Catskill Mountain Railroad was organized to-day. Judge Osborn, Isaac Pruyn, M. B. Mattice, C. H. Bagley, A. P. Jones, Wm. Donahue, Hiram Van Steenburgh, H. A. Person, John Avery, Wm. W. Ryder, A. J. Martin, J. F. Gaylord and Joshua Fiero were elected directors.

Messrs. Beemar, of Ottawa, and Laberge, of Montreal, have been awarded the contract for the improvements at the Hochelaga station of the Q., M., O. & O. Railway. They will probably entail an expenditure of over $200,000, and consist of crib work, masonry, earth excavations, and probably the building of a station house.

Gen. Thom has made a report to the Aldermen and Mayor of Portland, which in turn has been presented to Congress, recommending the dredging of the "middle ground" in Portland harbor, in view of Portland's growing commercial importance and the necessity of improved terminal facilities for the railroads centering there. The expense is estimated at $160,000. He also recommends the building of a breakwater in the St. Croix River, below Calais, at a cost of $4,000.

A Washington dispatch of the 10th says: "The bill reported by Senator Vorhees, to-day, from the Committee on Library, authorizing the construction of a new library building, provides for the erection of a fire-proof building on Judiciary Square, according to a plan to be adopted by the joint select committee on library building. The bill appropriates $1,500,000 to commence its construction, and also provides it shall be in charge of a commission composed of the Secretary of the Interior, the architect of the capitol and the librarian of Congress, and that the appropriation shall be disbursed by the Secretary of the Interior."

Governor Long, of Massachusetts, in his message, makes the following suggestion: "The continued and increasing use of the Charles and Mystic rivers as reservoirs of sewage will be brought before you by the same board. The foul condition of either stream will be an injury to both health and comfort in the towns near its mouth, however good their own drainage may be. As it is not possible for any one of these towns to carry out a system of sewerage that is not liable to injure a neighboring town, some sort of concerted action is necessary; and it is suggested that this board or some other competent authority have power to arrange, or at least to report upon, a comprehensive system for draining the entire area embraced within a semi-circle of a radius of 10 miles from the State-house. How great their interest in this matter is, appears in the fact that 17 of them contain more than half the valuation and more than a third of the population of the whole commonwealth."

OTTAWA, Ont., Jan. 10.—The formation of a rival syndicate to construct the Pacific Railway creates a sensation in political circles here. It is said that Mr. Cramp, of Messrs. Cramp, Torrance & Co., of Montreal, Thomas Workman, Hugh McKay and C. J. Bridges, of Montreal, each of these gentlemen being a representative in the general syndicate of bodies of smaller capitalists, have joined the syndicate. Mr. Ross, a well-known Quebec capitalist, will also become a member of it. No formal offer has been made by the syndicate yet to the Government, but it is understood that a general meeting of the syndicate will take place in the course of a few days, when a final determination and the details of an offer to be submitted to the Government will be arrived at. It is said that a prominent American capitalist, of considerable experience in the construction and operation of possibly the longest railway on this continent, has also entered the syndicate. He is the only American in the syndicate.

A corporation has been formed, under the name of the Lehigh & Hudson River Railroad Company, for the perfection of a through line between the Hudson River at Newburgh and the Delaware River at Belvidere, N. J. The purpose is to build twenty-three miles of road between Belvidere and Andover, use the Sussex Railroad or build an independent line from there to the McAfee terminus of the Warwick Valley Railroad, and run over the latter road to its connection at Greycourt with the New York, Lake Erie & Western and Newburgh branch. The plan includes the consolidation under one management of the whole route between Greycourt and the Delaware River. Connection at Newburgh will be had with the New York & New England Railroad, now being built, and at the western end of the route with the Lehigh Valley and other roads, making the line an important one between New England and the coal fields of Pennsylvania. Much of the line is located, and a portion will be put under contract in a few weeks. The road is to be completed next fall. The company's officers are: Grinnell Burt, President; George R. Blanchard, Vice-President; Alfred Ely, Secretary; D. B. Halsted, Treasurer.

BUILDINGS.

It is stated that the building operations in Joliet, Ill., will cost over $300,000.

A contract for a new school building at Joliet, Ill., to cost $30,000, has been signed.

Building permits for 1,507 brick and 347 frame buildings were granted in St. Louis last year, the cost of the new buildings and additions amounting to $3,790,650.

Building permits in Boston for the last 10 years number 10,898, of which 3,897 were for brick and 6,819 for wooden buildings. The permits for the past year were 808, of which 309 were for brick and 494 for wood.

The new city hall, at San Francisco, is proving an expensive investment for the city. The cost of construction by the commission appointed for the purpose has already been $2,776,719, in addition to some $300,000 expended by the supervisors, who had charge of the enterprise for a year before the commission took hold of it. The architect also estimates that $1,500,000 will be needed to finish it, making a total cost of over $4,500,000.